Dr. Airy's Report to the Local Government Board on an Outbreak of Enteric Fever at Pemberton and Orrell, in Lancashire.

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Information of an outbreak of fever at Pemberton was conveyed to the Board by a Report of the Medical Officer of Health for the Pemberton urban sanitary district, which was received on September 7, 1880, stating that 27 cases had occurred, one being fatal.

On my visiting the Pemberton district, by order of the Board, for the purpose of inquiring into the circumstances of the outbreak, it was at once apparent that the epidemic had assumed serious proportions, and that the urban district of Orrell, adjoining that of Pemberton, had shared in it. I was therefore instructed to include the Orrell district in my inquiry.

The Pemberton urban sanitary district, coterminous with the township of the same name, adjoins the western border of the Wigan and Ince-in-Makerfield townships. The boundary between them is formed by the Ince Brook and the River Douglas. From the bottom of the Douglas valley at Wigan the ground rises westward to a height of 260 feet at Lamberhead Green, the chief village in the district at its extreme western border. Part of this village lies in the township of Orrell. The ground continues to rise westward in Orrell township to a height of about 300 feet. Northward and north-eastward it falls away to the Douglas, and towards the south the ground slopes more steeply to the Withington brook, which is the southern boundary of Orrell township. Pemberton township extends some distance to the south of this brook.

The soil is composed of the clay and shale of the coal measures. At several points along the course of the Withington brook, seams of coal are seen cropping out. Several large collieries are established in both Pemberton and Orrell districts. The country is extensively undermined with their workings, and the surface is dotted with pit-mouths, old and new.

The population of Pemberton township in 1861, was 6,870; in 1871, it had risen to 10,374. That of Orrell was 2,932 in the former year, and 3,561 in the latter. The people are chiefly employed in the coal mines and cotton mills.

Putting myself in communication with the Clerk to the Pemberton Local Board, Mr. P. Partington, the Medical Officer of Health, Mr. R. Hartley, and the Inspector of Nuisances, Mr. John Somers, I was furnished with a list of 75 families that had been visited by the sanitary officers, on account of fever, during the week ended September 11. In two instances, the fever was scarlet fever. In the remainder there was no doubt that it was true enteric fever, characterised as it was by diarrhœa, and, in some cases, hæmorrhage from the bowels, with continued fever of low type. It was, however, generally noticed that the rose-coloured spots which constitute an important indication of this disease, were not present, or at least were not conspicuous. Mr. Hartley accompanied me to several houses where cases of fever were then in progress. In one house, a father and two sons lay ill in one bed, and two daughters in another; severe cases of unmistakeable enteric fever.

On extending the inquiry into the adjoining urban sanitary district of Orrell, and supplementing from other sources the information first received, the list of recognised fever cases rose to 150; and there was reason to think that this enumeration was far from complete. Up to the 17th of September, when I examined the death register, 6 deaths from "typhoid" or "enteric" fever, and one (of a male, aged 48) from "summer diarrhœa," had been registered in the Pemberton sub-district since June. Subsequently, within the third quarter, the deaths registered from typhoid or enteric fever amounted to nine. It would seem, therefore, that the mortality in this epidemic was not great as compared with the number of persons attacked.

In many cases, especially among club patients (of whose treatment record is not always kept by the medical attendant), there was great uncertainty as to the date of attack, and much difficulty in obtaining a trustworthy statement of the circumstances preceding and attending it. The following, however, was the history of the outbreak, as well as I could ascertain with the assistance of the Medical Officer of Health and Inspector of Nuisances.

Since May, 1880, when a death from typhoid fever was registered as having occurred at a house between Wigan and Lamberhead Green, it was not known that any case of that disease had occurred until the second week in July. Three persons living in different streets in Lamberhead Green, came under treatment on July 13, 20, and 27. They all recovered. No fresh cases appeared till the beginning of the second week in August, when four or five persons were taken ill on as many successive days, in as many different families, and in different parts of the district. On the 14th and following days, a great increase in the epidemic took place. Fresh families in different directions were found to have the infection, at the rate of four or five a day, and from the 14th to the 23rd, perhaps as many as 80 persons were attacked. From that date the epidemic began to decline, but still at the time of my visit, in the middle of September, a few scattered cases, here and there, were discovered. The disease was most prevalent at Lamberhead Green, where it first broke out; but it also extended, in the Pemberton district, to Highfield, Newtown, Marsh Green, Goose Green, and Kitt Green; and in the Orrell district, to Orrell Post, and Far Moor. This wide extension of the disease within so short a time points apparently to some medium of conveyance of the infection common to the greater part of the region affected by it. We have to ask, in particular, how far there was among the infected places community of water-supply, of milk-supply, and of sewerage, for in either of these three ways enteric fever is well known to be conveyable.

The Medical Officer of Health was of opinion that the epidemic extension of the disease was due to polluted water-supply. He pointed out to me that the majority of inhabitants in Lamberhead Green, and some at Highfield, at Kitt Green, and at Goose Green, obtained drinking water from a spring called Pingot Well, situated close by the side of the Withington Brook, only a few inches above the ordinary level of the brook, and liable to be overflowed by the brook after heavy rains. He mentioned also that about a week before the great outburst of the fever (which took place on August 14th) there had been a violent rain-storm. This is confirmed by the rainfall records kept at the office of the Wigan Waterworks. By the courtesy of the Borough Engineer, I am able to give the daily record from July 1 to September 17.

RAINFALL AT WIGAN WATERWORKS.

—	Inches.	—	Inches.	—	Inches.
1880. July 1	·03	1880. August 1	·04	1880. September 1	·06
„ 2	·51	„ 2	·00	„ 2	·00
„ 3	·31	„ 3	·07	„ 3	·00
„ 4	·00	„ 4	·00	„ 4	·00
„ 5	·00	„ 5	·04	„ 5	·12
„ 6	·60	„ 6	·13	„ 6	·00
„ 7	·24	„ 7	1·21	„ 7	·00
„ 8	·43	„ 8	·00	„ 8	·00
„ 9	·02	„ 9		„ 9	·06
„ 10	·00	„ 10		„ 10	·29
„ 11	·19	„ 11		„ 11	·00
„ 12	·27	„ 12		„ 12	·62
„ 13	·08	„ 13		„ 13	·09
„ 14	·05	„ 14		„ 14	·18
„ 15	·01	„ 15		„ 15	·18
„ 16	·00	„ 16		„ 16	·00
„ 17	·77	„ 17		„ 17	·33
„ 18	·36	„ 18			
„ 19	·06	„ 19			
„ 20	·00	„ 20			
„ 21	·00	„ 21			
„ 22	·04	„ 22			
, 23	·05	„ 23			
„ 24	·46	„ 24			
„ 25	·20	„ 25			
„ 26	·78	„ 26			
„ 27	·23	„ 27			
„ 28	·20	„ 28			
„ 29	·01	„ 29	·02		
„ 30	·41	„ 30	·00		
„ 31	·00	„ 31	·00		
Total - -	6·31	Total - -	1·51	Total - -	1·93

The fall of rain on Saturday, August 7th, amounted to 1·21 inches. The next three weeks were rainless, fine, and warm. The Registrar-General notes that from August 9th to September 12th, the average excess of daily temperature was 3°·9; and from August 9th to August 24th, within which period the chief outburst of fever took place, the barometer readings were on each day above their average values. There was distinct evidence that after the storm of August 7th the Withington Brook overflowed the Pingot Well, filling it with turbid water polluted by the drainage of villages on its upper course. At one of these villages, Longshaw, there had recently been cases of choleraic diarrhœa, suggestive of "blood poisoning," from which there was no doubt some of the excreta passed into the brook. Whether the Pingot Well would retain specific pollution for many hours after the flood had gone down is doubtful, for the spring is a strong one and its basin is shallow, surrounded by a low dilapidated circular wall of stone, on the brink of which the women and children stand to dip their cans. After a flood a muddy sediment remains on weeds at the bottom of the basin, which might contain matter specifically poisonous; this would probably be stirred in dipping the cans, and in this way possibly the spring might retain infective properties.

It was known that at least one water-carrier had filled his barrel at the Pingot Well on the morning of August 8th, when the well was flooded by the brook. Probably some others did the same. But it was impossible to obtain a list of the customers to whom the turbid water had been sold—impossible even to ascertain what families were drinking Pingot water at all at that time, for most of the houses have rain-butts, and after the storm of August 7th the rain-butts would be well replenished, and there was little doubt that the poor would and did drink rain-water rather than buy Pingot water at ½*d.* a can, the usual tariff.

In addition to this uncertainty about the Pingot water, there is the difficulty that among the nearly simultaneous attacks which it is sought to explain, there were some which were almost certainly unconnected with it. Such cases there were at Orrell Post, at Far Moor, and at Marsh Green, each of which places has a separate supply of water. Some of these might possibly be referable to independent sources of infection, if not originating *de novo.* The cases which occurred at Lamberhead Green in July might possibly be due to some earlier fouling of the Pingot water, but were more probably caused in some other way.

There is certainly much ground for suspecting that the Pingot water may have been concerned in causing the outbreak at Lamberhead Green in August, but the evidence is not conclusive.

It may be asked, might not the whole of the water in the stratum whence the Pingot well and other springs in the neighbourhood take their rise, have become contaminated by the storm of August 7 washing into the soil the liquid filth of the privies on the higher ground, or possibly by leakage from the sewers? If this were possible, it would be more easy to understand the distribution of the fever to all the villages on and around the Lamberhead Green hill, and also the limited duration of the infective agency. The difficulty in the way of this explanation lies in the wide extent of the water-stratum supposed to be infected, and the brief space of time, after the storm of August 7, within which the supposed infection must have taken place.

Milk cannot be supposed to have had any share in spreading the infection, for of the families attacked many took no milk at all, and the rest obtained it from a number of different sources which could not be suspected of having become contaminated all at the same time.

Community of sewerage did to a certain extent obtain in the region affected by the epidemic, but with exceptions even more numerous and more difficult to account for, on the hypothesis of sewer air being the cause of the spread of the disease, than in the case of the water supply. In the Pemberton district, there is a comprehensive system of sewers, whereby the sewage from Lamberhead Green, Goose Green, and Worsley Mesnes, is brought by separate mains to a meeting point at Newtown, near Wigan. Thence it passes by one outfall to a tank at a pumping station, which receives also a separate sewer from Marsh Green; and thence it is pumped up to a sewage farm on the slope of the valley side, within the urban district. The sewage from Kitt Green comes by gravitation direct to the farm without passing through the pumping station. Provision is also made for diverting the sewage of Lamberhead Green from the main sewer by a lateral branch which shall convey it direct to the sewage farm. This lateral branch begins at a manhole on the line of the main sewer by a grated opening at a lower level than the main itself. At the time of the heavy rainfall on the 7th of August this lateral diversion of the Lamberhead Green sewage was supposed to be in force, but there is good reason for believing that the lateral grating was about that time obstructed by solid matters, and that the bulk of the sewage passed, and had for some time been passing, along the main line to the pumping station. Now it is certain that the sewer at Lamberhead Green had received matters carrying specific infection from the early cases of enteric fever in July; and it may be inferred that the infection became common to the air throughout the whole extent of the communicating sewers. The sewer air, thus presumably infected, was, on the occasion of the flood of August 7, forced out of the sewers by the storm-water which filled the whole of the outfall main from the pumping station to Newtown, a distance of half a mile. The ventilation of the sewers is very imperfect, and many house-drains are in untrapped communication with them. By these ways the up-forced sewer air would escape into or around the dwellings, and from this cause it is conceivable a wide-spread outbreak of fever might arise. This hypothesis, however, would not account for cases at Marsh Green, which has an independent sewer to the pumping station, nor for cases at Kitt Green, which is drained direct to the sewage farm, nor for cases at Orrell Post and Far Moor, which are not in any way connected with the Pemberton sewerage.

It would carry us too far into the realm of conjecture to ask if an outburst of enteric fever could be determined by the conditions of heavy rainfall followed by heat and drought operating upon filthy privies and overflowing cesspits. The limitation of the outbreak in point of space would at least show that some other factor is necessary besides those here mentioned.

No likely clue to the full elucidation of the outbreak was found in any other direction.

Mortality statistics.

The Medical Officer of Health for the Pemberton Urban district, in reporting this outbreak to the Sanitary Authority, observed that there had been nothing like it in the district during the past seven years. It must not be supposed, however, that the Pemberton sub-district had been unfamiliar with mortality from enteric fever. Looking to the Registrar-General's Quarterly Returns from 1870 to 1879 inclusive, it is seen that the average number of deaths yearly from "fevers" in this sub-district has been 14·4, giving an average annual death-rate from this cause of about 0·84 per 1,000, a rate exceeding that for the "20 large towns" for which the Registrar-General makes a special return in Table 27 of his 41st Annual Report, p. 257.

From other diseases also of the zymotic class, the Pemberton sub-district has suffered severely. The following Table shows the death rates from these causes, and from all causes combined, in the 10 years 1870–9, calculated from the Registrar-General's Returns on an estimated population of 17,170, that estimate being based on the number of births in the same period.

BIRTH and DEATH RATES in the PEMBERTON SUB-DISTRICT, compared with LARGE TOWNS in the UNITED KINGDOM.

——	Pemberton Sub-district, 1870–79.	Large Towns.
Births per 1,000 of population - - - -	43·8	36·80* (1878).
Deaths ,, ,, from all causes - -	23·46	24·76* (1874–78).
,, ,, ,, ,, small pox - -	0·16	0·51† (1870–77).
,, ,, ,, ,, measles - -	0·79	0·51† ,,
,, ,, ,, ,, scarlatina - -	1·28	0·90† ,,
,, ,, ,, ,, diphtheria - -	0·02	0·10† ,,
,, ,, ,, ,, whooping cough -	0·42	0·71† ,,
,, ,, ,, ,, fevers - -	0·84	0·60† ,,
,, ,, ,, ,, diarrhœa - -	1·67	1·31† ,,
,, ,, ,, ,, seven zymotic diseases	5·18	4·64† ,,
,, ,, ,, ,, violence - -	1·31	0·75‡ (1870–78).
Deaths of children under one year per 1,000 of births -	168·0	176·73§ (1870–77).

* Registrar-General's 41st Report, p. xcii., Table 40 (for 23 towns).
† ,, ,, pp. 254–7, Tables 21–28 (for 20 towns).
‡ ,, ,, p. 238, Table 4 (for England).
§ ,, ,, p. xxxv., Table xxviii. (for 20 towns).

The death rates from measles, scarlatina, fever, and diarrhœa are all noticeably in excess of the corresponding rates for 20 large towns, and so is the rate for the seven zymotic diseases taken together. At the same time the death rate from all causes is decidedly lower than that in the large towns, notwithstanding the larger mortality from accidents (chiefly in mining operations). This lower general death rate is probably due to the larger proportion of persons in the prime of life in the rapidly increasing mining and factory population of the Pemberton district.

Small-pox has caused but few deaths here. Still fewer, diphtheria. Indeed, the almost complete immunity from this latter disease is very remarkable, even when compared with the usually small urban mortality from this cause; much more when compared with such diphtheria death rates as are met with in some rural districts of England and Wales. The cause of this difference has yet to be found.

As to the Sanitary Arrangements of the Districts.

Water supply.

1. *Pemberton.*—As regards water supply, I have already mentioned that the bulk of the inhabitants get their drinking-water either from their rain-butts, or from springs and surface wells, at a considerable distance from their dwellings, and more or less exposed to pollution. In 1875 an Act was obtained for impounding the water of a brook, called the Withington Brook, at a point outside the Pemberton district, on the west side. A large reservoir was constructed at great expense, but on trial in 1878, it was found that the water escaped through the inclined and faulted strata of shale and coal, which form the floor. Pending remedial measures, a second Act was obtained, in 1879, for procuring a supply from a range of stone quarries, known as Bispham Delph, in the Billinge district, at a height of 430 feet (170 feet above Lamberhead Green). The filter bed and service tank are about 40 feet below the quarry. This work has been rapidly executed; the first house-connexion was made in May of this year (1880); at the time of my visit about 400 houses were thus supplied. The water is of good quality (an analysis of it is appended to this report) and sufficient in quantity. The supply is constant; by gravitation.

Sewerage.

The sewers appear to be well laid, but, as has already been noticed above, are insufficiently ventilated, and hitherto have been deficient in the matter of flushing. With the new supply of water there will be facility for remedying this defect.

Excrement disposal.

It is in the matter of privies and ashpits that the Pemberton district is in worst condition. Among the old crowded low-class dwellings in villages like Lamberhead Green the privies are planted in the narrow back yards, often close to the houses. Their contents accumulate in the uncovered rain-sodden ashpits, and are seldom removed before they have attracted the inspector's notice as nuisances. The removal is a matter of private arrangement with some farmer in the neighbourhood, who will only do the work at certain times, when he can spare man and horse from the farm work. I understood that the question had been brought forward at more than one meeting of the Sanitary Authority, whether they should not themselves undertake this very necessary work. I need hardly say that all experience goes to show that the work will not be effectually done, however vigilant the inspector of nuisances may be, as long as it is left in the hands of the occupiers.

I did not hear of any experiment having been tried with any form of earth or pail closet; though, with proper supervision on the part of the sanitary authority some such plan might probably be introduced with advantage.

The Sanitary Authority possess a small hospital which was originally provided to meet an outbreak of small-pox, but which was not brought into requisition during the recent epidemic of enteric fever.

They have no suitable means of disinfecting clothes, bedding, &c., by heat, but rely on the distribution of chemicals by the Inspector of Nuisances.

The detailed use of such disinfectants must in a great measure be left to the people themselves, and therefore cannot be trusted to be effectually carried out.

2. *Orrell.*—In the Orrell urban district, the water supply hitherto has been of the same general character as that in the Pemberton district, namely, from springs and surface wells. Arrangement is now made for supplying the greater part of the Orrell district from the mains of the Pemberton waterworks which traverse it between Bispham Delf and Lamberhead Green.

The sewage of the Orrell district is conducted into watercourses which bound the district on three sides, north, west, and south. The danger which this mode of sewage disposal may bring to riparian neighbours lower down the stream may be understood from the description above given, of the pollution to which the Pingot Well is exposed.

I understood, however, that a system of sewerage for the district has been planned, which will not be open to the objection here alluded to.

In privy accommodation and excrement disposal, Orrell follows the usual custom, which has been described in speaking of Pemberton.

No suitable means of isolating cases of infectious disease, or of disinfecting infected clothes and bedding, are possessed by the Orrell Urban Sanitary Authority.

HUBERT AIRY.

RECOMMENDATIONS.

PEMBERTON URBAN SANITARY DISTRICT.

1. The Pingot Well, if it is still to be used as a source of public water supply, should be made secure from pollution by overflow of the Withington Brook, or by surface washings from the space around it.

   Probably this object might best be gained by building over the well, and drawing from it by a pump.
2. Ample provision should be made for the ventilation and flushing of the sewers.

   Measures are required to prevent obstruction of the inlet of the lateral branch sewer, by which the sewage from Lamberhead Green should be conveyed direct to the sewage-farm.
3. It is much to be desired that the Sanitary Authority should organize the emptying of privies and ash-pits, either by men in their own employ or by a contractor or contractors, subject always to due supervision: and the inhabitants should be invited to report any neglect in the working of the system adopted.

   Ashpits should be covered and ventilated. Rain should not be allowed to enter them.
4. The Sanitary Authority should keep in view the importance of possessing and using proper means of isolating cases of infectious disease, and of disinfecting infected clothes, bedding, and other articles.

ORRELL URBAN SANITARY DISTRICT.

1. Now that a good supply of water has been laid on to the district, it would be advisable to close all other public sources of supply that are at all liable to suspicion of impurity, making other provision in lieu thereof.
2. A scheme of sewerage should be carried out as soon as practicable.
3. The emptying of privies and cesspits should be systematically carried out either by servants of the Sanitary Authority or by persons under contract with the Authority, subject to due supervision by an officer of the authority.
4. The Sanitary Authority should have some fit place for isolating and treating cases of infectious disease; and some suitable apparatus for disinfecting infected clothes, bedding, &c.

APPENDIX.

Analysis of the Water from Bispham Delf, by Ralph Betley, F.G.S., Wigan, October 1878.

	Grains per Gallon.
Total solids	26·9
Hardness, permanent	13·6
„ temporary	3·1
„ total	16·7
Chlorine	1·5

	Parts per Million.
Free ammonia	0·13
Albuminoid ammonia	0·10

Analysis of the Water from the Pingot Well, by the same Analyst, in 1873.

Condition of sample - - - - Clear.

	Grains per Gallon.
Total solids	22·68
Hardness before boiling	14·1
„ after boiling	12·9

Comparatively free from nitrogenous organic matter. It becomes disagreeable after standing some time, owing probably to the decomposition of sulphur compounds in the water. It is therefore ineligible as a sole source of supply, but might possibly be used to mix, in small proportion, with other water as a means of assisting the supply in dry weather.